

6 Wildlife Management

6.1 *Overview of Ware River Watershed Wildlife Community*

All species of wildlife depend on the existence and quality of various habitat types. Some species require very specific habitats to survive (e.g., wood frogs and vernal pools), while other species, such as coyote can exist in a variety of habitats. The Ware River watershed is comprised of a mosaic of habitats. Division-controlled land within the watershed is largely forested, while privately owned lands include small farms, fields, woodlots, and residential areas. Although as a whole the landscape is fragmented, Division-controlled land within the watershed is extensive and relatively contiguous. The undeveloped and relatively unfragmented nature of these lands is of tremendous benefit to wildlife species that require large tracts of habitat.

The Ware River watershed supports an impressive array and abundance of wildlife. Division forests provide habitat for a diversity of birds and mammals including moose, white-tailed deer, turkey, grouse, fisher, and bears. Neotropical migratory birds – including black and white warblers, rose-breasted grosbeaks, and scarlet tanagers – also utilize Division forests for breeding and as migratory rest stops. The Ware River watershed is dotted with wetlands, streams, and beaver ponds that support a variety of reptiles, amphibians, and birds. There are several multi-acre tracts of early-successional non-forested habitat within the Ware River watershed that provide habitat for species dependent on open lands, including eastern meadowlarks, bobolinks, and various insects.

One of the most important qualities of Division land in the Ware River watershed is its protection from development. Some towns within the watershed are experiencing tremendous growth, and as a result open space is being rapidly converted to residential or commercial uses. The protection that Division lands provide to wildlife species is critical to their long-term survival.

Several wildlife species are monitored by Division personnel or other agencies. For example, a yearly ruffed grouse survey is conducted each spring. In addition, permanent breeding bird surveys are conducted as part of a national effort. A new survey was begun in 2002 by Division staff to monitor moose populations within the watershed. Finally, data on vernal pools is collected each year.

While a great deal of information about certain wildlife taxa such as birds and mammals is available from surveys and observations, very little is known about other Ware River wildlife. A complete species list does not exist, and there is a paucity of information about reptiles, amphibians, insects, butterflies, dragonflies, and other more secretive species. It is quite probable that Division lands within the Ware River harbor state listed species that have yet to be documented.

6.2 *Wildlife Management Goals and Objectives*

The primary goal of the wildlife program on the Ware River watershed is to protect water quality from negative impacts associated with wildlife (for instance, preventing the distribution of pathogens that can be passed from wildlife to humans). Beyond water quality protection, the goals of the wildlife program are to protect important wildlife and their habitats while minimizing or eliminating adverse wildlife impacts on other watershed resources. In certain circumstances, active management to enhance wildlife habitat may occur. The specific objectives of the wildlife management program are to:

- MITIGATE ADVERSE IMPACTS OF WILDLIFE ON WATER QUALITY, INFRASTRUCTURE, AND OTHER WATERSHED RESOURCES.
- PROTECT UNCOMMON, RARE, AND OTHERWISE SIGNIFICANT WILDLIFE SPECIES AND HABITATS WHEREVER THEY EXIST ON DIVISION LANDS.
- ASSESS AND MITIGATE IMPACTS OF WATERSHED MANAGEMENT ACTIVITIES ON WILDLIFE THROUGH A PROCESS OF NOTIFICATION, SITE VISITS, REVIEW OF RECORDS AND LITERATURE, AND RECOMMENDATIONS TO APPROPRIATE MANAGEMENT STAFF.
- ACTIVELY MANAGE FOR SELECTED WILDLIFE SPECIES THAT ARE CONSIDERED TO BE COMMON, RARE, OR UNIQUE ON A REGIONAL OR STATEWIDE BASIS.

Certain wildlife species within the Ware River watershed can negatively impact both infrastructure and other critical resources in certain areas. Mitigating these impacts will be a top priority.

Although the focus of this plan is the protection of water resources, the Division recognizes that its land management activities may impact certain wildlife species or habitats. It is a Division goal to avoid adversely impacting significant wildlife species or their habitats. This will be accomplished primarily through inventory and survey work to locate rare species and habitats, proper coordination with MassWildlife's Natural Heritage and Endangered Species Program, and proper precautions using management guidelines and Conservation Management Practices (CMPs) in all timber harvesting and other management practices.

While directly protecting rare or endangered wildlife will be a priority, the Division recognizes that its management activities have the potential to impact more common wildlife. Another objective is to assess the impacts of these land management activities on the wildlife communities at the Ware River, and thereby minimize adverse impacts. This will be accomplished through long-term monitoring programs and an in-house review process for all planned management activities.

On certain portions of the watershed, it may be feasible and desirable to proactively manage the habitat for the benefit of wildlife. This level of land management is a step beyond habitat protection and is focused on either habitats or wildlife species that are rare or of special concern on a regional or statewide basis. Some activities might include prescribed burns to enhance a field or meadow, selective removal of exotic plants, erecting nesting platforms for certain species of birds, or creating brush piles or rock piles.

6.3 Conservation Management Practices (CMPs) for Wildlife Management

Division foresters are concerned primarily with maintaining water quality standards and improving forest health and vigor. Monetary gain from forest resources is a secondary consideration when planning forest management activities. A direct result of this flexibility is that it allows Division foresters to incorporate sound and beneficial wildlife management components into their forest cutting plans. For instance, high quality mast trees, active and potential den and nest trees, and critical habitats have been and continue to be conserved and even enhanced during silvicultural operations. Specific wildlife habitat management recommendations are described in detail below.

6.3.1 Vernal Pools

Vernal pools are contained basin depressions with no permanent outlet and typically hold water for at least 2-3 months in the spring and summer. Vernal pools may or may not dry completely each year, but their periodic drying, shallow water, winter freezing, low oxygen levels, and lack of a permanent outlet keeps them free of fish populations. Because of their unique characteristics, vernal pools play a



critical role in the life cycles of many amphibians, reptiles, and invertebrates. As a result, the Division considers vernal pools to be critical wildlife habitats. In fact, many state-listed species are associated with or dependent on vernal pools. Many vernal pools dry completely during the late summer and fall and can be difficult to identify. In recent years, the Division has made efforts to locate and identify vernal pools during the spring. Accurate and detailed records of located pools, including UTM coordinates, physical characteristics and animal use, are stored in Division databases. In addition, the University of Massachusetts recently identified over 400 “potential” vernal pools on the Ware River

watershed through aerial photos. These locations have been digitized, and in the future, will be field checked to determine their support for breeding. Locations of both potential and documented vernal pools have been transferred to a GIS datalayer for inclusion in land management planning documents.

Research is currently being conducted at Quabbin Reservation to test the effectiveness of Massachusetts Best Management Practices for vernal pools. While the state BMPs provide direct protection of the pool, there is concern that the wildlife species utilizing the pool may also rely on a larger area surrounding the pool for a majority of their life cycle. This research will test the effectiveness of the current BMPs.

Vernal Pool Management Objectives: DCR/DWSP is working to locate and identify all vernal pools on Division property and to avoid adverse impacts to vernal pool depressions and adjacent habitat.

Recommended Practices for Vernal Pools:

- SEEK ADDITIONAL INPUT FROM NHESP WHEN MANAGEMENT ACTIVITIES ARE GOING TO OCCUR AROUND A POOL THAT CONTAINS STATE-LISTED SPECIES.
- DIGITIZE ALL AERIALLY INTERPRETED VERNAL POOLS AND PROVIDE THE DATALAYER TO GIS PERSONNEL FOR INCLUSION IN LAND MANAGEMENT ACTIVITY PLANS.
- IDENTIFY AND CONFIRM BREEDING USE IN PHOTO-INTERPRETED VERNAL POOLS.

WITHIN POOL DEPRESSION:

- MAINTAIN PHYSICAL INTEGRITY OF POOL DEPRESSION AND ITS ABILITY TO SEASONALLY HOLD WATER.
- KEEP DEPRESSION FREE OF SLASH, TREETOPS, AND SEDIMENT FROM FORESTRY OPERATIONS. IF SLASH DOES FALL INTO POOL DURING THE BREEDING SEASON DO NOT REMOVE IT SO BREEDING ACTIVITY IS NOT DISTURBED.

EDGE OF POOL:

- KEEP SHADED CONDITION IN 100-FOOT BUFFER AROUND POOL DEPRESSION.
- MINIMIZE DISTURBANCE OF FOREST FLOOR WITHIN 200 FEET OF POOL EDGE.
- AVOID MAKING RUTS >6 INCHES DEEP WITHIN 200 FEET OF POOL.
- CONDUCT LOW-INTENSITY HARVESTS PREFERABLY WHEN GROUND IS FROZEN.

6.3.2 Seeps

Woodland seeps tend to be small (< ¼ acre) areas where ground water flows to the surface of the forest floor and saturates the soil. Seeps generally don't freeze during the winter and typically have little or no snow cover. Seeps often occur in natural depressions and may act as "seed traps" in which nuts, seeds, and fruits from surrounding trees and shrubs accumulate. This makes them important winter feeding sites for turkey, deer, and other wildlife.



Seeps provide a seasonally important source of food and water for resident and migratory wildlife (Hobson et al., 1993). These areas tend to have early sources of green vegetation, which can be an important food source for black bears in the spring and early summer. Earthworms and insects at seeps attract early migrants such as robins and woodcock. Spring salamanders and hibernating frogs, which can attract skunks and raccoons, may also use seeps.

Seep Management Objective: The Division will continue to protect seeps, springs, and surrounding soils.

Recommended Practices for Seeps:

- AVOID LEAVING SLASH IN WOODLAND SEEPS OR SPRINGS.
- MAINTAIN MAST-PRODUCING TREES ABOVE AND AROUND SEEPS.
- REMOVE CONIFER TREES ON SOUTH SIDE OF SEEP; RETAIN CONIFERS ON NORTH AND WEST SIDES.
- WHERE SEEPS ARE PRESENT, SCHEDULE HARVESTS TO OCCUR ON FROZEN GROUND OR DURING THE DRIEST CONDITIONS.
- AVOID RUNNING HEAVY EQUIPMENT WITHIN 50 FEET OF THE EDGE OF A SEEP.
- WHEN FEASIBLE, USE SEEPS AS THE CENTER FOR UNCUT PATCHES TO RETAIN CAVITY TREES, SNAGS, AND OTHER WILDLIFE FEATURES.
- IN STANDS WHERE SEEPS ARE PRESENT, LAY OUT SKID TRAILS AND ROADS PRIOR TO HARVEST, WHEN SEEPS ARE OBVIOUS.

6.3.3 Orchards

Abandoned apple orchards and scattered fruit trees exist on Division property. Wild apple trees are one of the most valuable wildlife food species in the Northeast (Elliot 1988, Tubbs et al., 1987, Hobson et al., 1993). White-tailed deer, grouse, squirrels, fox, fisher, porcupine, and rabbits will eat apples or apple seeds. Apple trees also provide nesting and perching habitat for bluebirds, flycatchers, robins, orioles, and sapsuckers (Elliot 1988). Apple trees in abandoned orchards eventually become crowded by invading shrubs and over-topped by the encroaching forest. Prolonged crowding and shading will lead to decreased vigor and eventually death.

Orchard Management Objective: The Division will save apple and other fruit trees when possible and increase their health and vigor when feasible.

Recommended Practices for Orchards:

- CONTINUE TO IDENTIFY ABANDONED ORCHARDS AND CLUSTERS OF FRUIT TREES, AND IF POSSIBLE, RETAIN ALL FRUIT TREES.
- WHEN FEASIBLE, REMOVE ALL BRUSH AND SHRUBS UNDER THE DRIP LINE OF THE FRUIT TREE.
- IF THE FRUIT TREE IS SHADED BY LARGE OVER-TOPPING TREES, REMOVE ALL COMPETING TREES, LEAVING THE FRUIT TREE IN AN OPENING.
- WHEN POSSIBLE, PRUNE, LIME, AND FERTILIZE TREES AT LEAST EVERY 3 YEARS.

6.3.4 Wildlife Wintering Areas



Wildlife wintering areas (WWA) provide shelter and food for animals during the winter months when cold temperatures, snow cover, and limited food resources create physiologically demanding conditions. Deer wintering areas (DWA) typically are in hemlock or pine stands where there is >70 percent conifer crown closure (Elliot 1998). Deer typically move to these areas when snow depths are around 12" (Flatebo et al., 1999). DWA provide reduced snow depths, higher nighttime temperatures, reduced wind, and greater relative humidity (Flatebo et al., 1999). The best DWA not only provide adequate cover, but also a quality supply of deer food.

Cedar, red and sugar maple, birch, and hemlock are preferred foods. Another important WWA is dense conifer cover such as spruce stands that provide increased thermal protection and wind cover for a variety of birds and mammals. For example, grouse will seek conifer stands for thermal protection when snow depths are <8".

The general guideline for wildlife wintering areas is to maintain as much overstory as possible, while providing for the establishment and continued growth of preferred browse and conifer tree species.

Wildlife Wintering Areas Management Objective: The Division will maintain the functional value of wildlife wintering areas.

Recommended Practices for Wildlife Wintering Areas:

- IDENTIFY AND MAP ALL KNOWN OR POTENTIAL WWA USING AERIAL PHOTOS, COVER TYPE MAPS, AND FIELD INSPECTIONS.
- WHEN FEASIBLE, SCHEDULE FOREST HARVEST OPERATIONS DURING DECEMBER-APRIL NEAR WWA SO TREE TOPS ARE AVAILABLE FOR BROWSE.
- PROTECT ADVANCE CONIFER REGENERATION DURING TIMBER HARVEST.
- CUT STUMPS LOW TO ENCOURAGE VIGOROUS SPROUTING.
- PLANNED ACTIVITIES WITHIN WWA SHOULD BE CONDUCTED TO ENSURE THAT AT LEAST 50% OF THE WINTERING AREA REMAINS IN CLOSED CANOPY CONIFEROUS OVERSTORY TO PROVIDE FUNCTIONAL SHELTER.
- AVOID CONCENTRATING HARVEST IN ANY ONE AREA OF THE WWA.
- TRY TO MAINTAIN TRAVEL CORRIDORS (UNBROKEN, DENSE SOFTWOOD COVER 60-100M WIDE) THAT CONNECT ALL PORTIONS OF THE WWA.

6.3.5 Mast

Mast is a critical component of quality wildlife habitat. Trees, shrubs, and vines produce fruits, nuts, and berries called mast. Mast can be hard (nuts, seeds) or soft (fruit, berries). It contains more fat and protein than other plant foods and is actively sought by a variety of birds and mammals. In autumn, mast is particularly important as many animals will focus on eating mast in preparation for winter. Bears, squirrels, raccoons, deer, and turkey will fatten up on acorns, beechnuts, and hickory nuts. Resident songbirds such as nuthatches, chickadees, and bluejays rely on mast during winter when other food is scarce. Migrating birds will often rely on fruits and berries during migratory stops to replenish energy.

Although all trees and shrubs are defined as mast producers, some species are more important to wildlife. The value of mast to wildlife differs with the size, palatability, accessibility, nutritional content, abundance, and production frequency (Flatebo et al., 1999). In general, oak, hickory, beech, walnut, butternut, cherry, ash, and conifers are the most important mast trees. In addition, birch, hazel, alder, and aspen are also important to some wildlife species.

6.3.5.1 Hard Mast

At the Ware River, red, white, black, and scarlet oaks are the most important source of hard mast. Hickories and beech comprise a relatively small component (2%) of the overstory. Oaks are probably the most important wildlife mast trees in the northeast. Acorns are eaten by over 100 species of birds and mammals (Healy 1997). The frequency and characteristics of oak production varies from species to species. Red oaks produce a good crop of acorns every 2-5 years, black oaks every 2-3 years, and white oaks every 4-10 years. Red and black oak acorns take 2 years to develop, while white oaks take only 1 year. Peak acorn production begins at around 25 years for red oaks, 40 years for white oaks, and 40-75 years for black oaks (Flatebo et al., 1999). White oak acorns contain less tannin and may be more palatable to wildlife.

Beech and hickory trees comprise a smaller component of the Ware River watershed forest. Hickories are scattered around the watershed, usually interspersed with oaks. They have good seed crops every 1-3 years and begin producing quality crops at 40 years. Hickory nuts have one of the highest fat contents of any mast. Beech trees occur irregularly across the watershed. The prevalence of beech bark disease and low market demand has shifted attention away from this species. However, beechnuts can be an important source of food for a variety of wildlife. Wild turkeys prefer beechnuts to all other mast (Williamson undated).

The seeds of maples, birches, ashes, and conifers provide food for many birds and small mammals. Red squirrels rely heavily on conifer seeds and their populations will fluctuate in response to annual crops. Birches are an important mast producer because most of the seed crop is retained on the tree above the snow. Birds, including pine siskins and grouse, rely heavily on birch seeds for their winter diet. White and red pines are the most widely distributed conifers at the Ware River. Mice, voles, grosbeaks, and finches are a few of the animals that utilize conifer mast. Chickadees and goldfinches prefer hemlock seeds.

6.3.5.2 Soft Mast

Black cherry trees comprise a relatively small percentage of the Ware River watershed forest canopy. However, bears, small mammals, and over 20 bird species eat cherries (Flatebo et al., 1999). Pin and chokecherries are short-lived, but provide valuable fruit to wildlife. A variety of understory shrubs and trees produce soft mast. Blueberries, serviceberries, dogwoods, and viburnums are abundant. In addition, herbaceous plants such as blackberry, raspberry, wild strawberry, and partridgeberry are utilized.

Mast Management Objective: The Division will continue to maintain and encourage a variety of mast-producing plants within the watershed.

Recommended Practices for Mast:

- MANAGE FOREST STANDS TO CONTAIN MULTIPLE SPECIES OF MAST-PRODUCING TREES AND SHRUBS.
- RETAIN PRODUCTIVE BEECH, OAK, AND HICKORY TREES WHEN THEY OCCUR AS SINGLE OR SCATTERED TREES IN STANDS DOMINATED BY OTHER SPECIES.
- RETAIN BEECH TREES WITH SMOOTH OR BLOCKY BARK OR RAISED LESIONS TO PROMOTE RESISTANCE; REMOVE STANDING TREES WITH SUNKEN CANKERS OR DEAD PATCHES TO REDUCE SPROUTING OF DISEASED INDIVIDUALS. RETAIN SOME LARGE BEECH TREES THAT HAVE POTENTIAL FOR GOOD MAST PRODUCTION, REGARDLESS OF DISEASE CONDITION.
- LAY OUT SKID TRAILS AND ROAD TO AVOID VIGOROUS PATCHES OF UNDERSTORY SHRUBS.
- WHEN POSSIBLE, SAVE ALL HARDWOOD MAST TREES THAT OCCUR IN CONIFER PLANTATIONS.

6.3.6 Wildlife Trees

Wildlife trees are often divided into two categories: snags and den trees. Snags are standing dead or partially dead trees at least 6" dbh and 20' in height. Den trees are live trees possessing a cavity large enough to serve as shelter for birds and mammals or a site to give birth and raise young. In general, den trees must be 15" or greater in dbh and have a minimum cavity opening of 4" in diameter (Blodgett 1985). Over 50 species of northeastern birds and mammals utilize snag and den trees during part of their lives (Blodgett 1985). Some uses of snags and den trees include cavity nest sites, nesting platforms, food cache, dwellings or dens, nesting under bark, overwintering sites, hunting and hawking perches, sources of feeding substrate, and roosting.

Forestry operations most likely have the greatest potential impact on the number, type, and location of snag and den trees at the Ware River. Thinnings, salvage, firewood cutting, and windthrow will result in wildlife tree loss. However, the Division's use of uneven-aged management is conducive to snag management. Single-tree or group selection harvest practices allow the maintenance of an optimal number of snags and dens across the watershed (Table 12).

TABLE 12: OPTIMUM NUMBER OF SNAGS AND DEN TREES PER 100 ACRES BY HABITAT TYPE

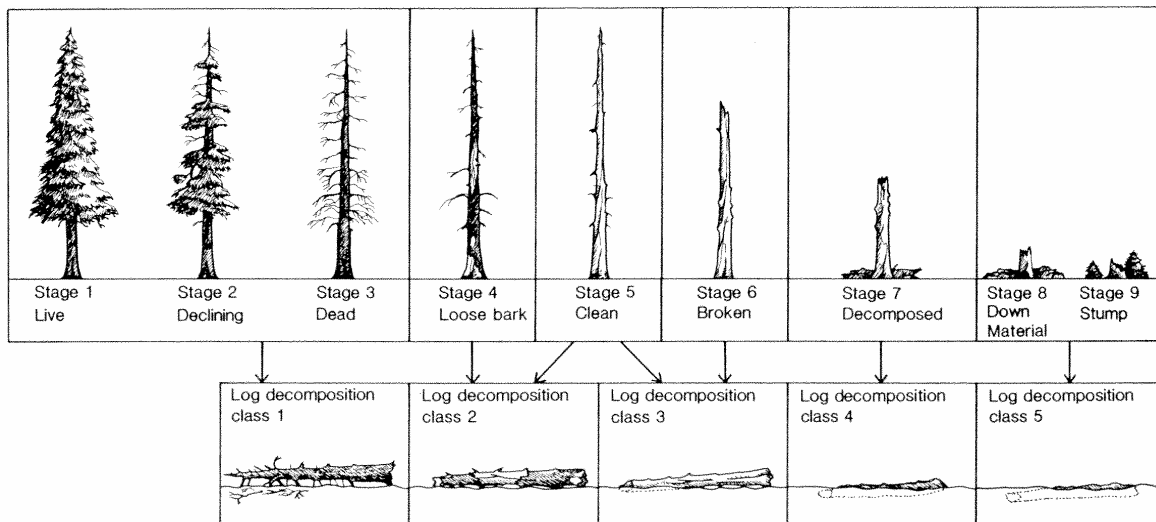
Tree Size	Forest Interior		Semi-open/open	Wooded Watercourse
Tree dbh (inches)	Dens	Snags	Dens ¹	Dens ¹
> 19	100	0	300	200
10-19	400	400	400	1400
< 10	200	200	300	900

¹ Animals here need den trees because creating snags by deadening trees is not recommended in these land-use patterns.
Source: Payne and Bryant, 1994

6.3.6.1 Snags

As a tree dies, it progresses through several stages of decay (Figure 11) and is used by different wildlife at each stage. Newly exposed bare branches provide excellent perches for woodland hawks (Cooper's, sharp-shinned), as well as flycatchers and phoebes. During the loose bark stage, brown creepers and bats may nest or roost under the bark.

FIGURE 11: DECOMPOSITION STAGES OF SNAGS AND DOWNED WOODY LOGS (HUNTER, 1990)



As a tree deteriorates, primary excavators (woodpeckers) begin to create cavities. Almost all northeastern woodpeckers excavate nest cavities in live or dead trees. Secondary nesters then use these cavities. Once trees have decayed to a point where there are no longer branches, it is classified as a snag (< 20 feet tall is a stub). Many insectivorous birds will use the snag for foraging. Finally the snag will either topple to the ground or wear to a stump. The fallen log provides habitat for carpenter ants and other insects. In addition, amphibians and reptiles will live in and under the rotting wood. Small mammals also utilize the downed logs.

In addition to the stages of decay, other variables determine a particular snag's value to specific wildlife species. Characteristics such as tree size, location, species, and how it was killed are important determinants of wildlife use (DeGraaf and Shigo 1985). In general, when managing for cavity trees, "bigger is better." While small birds are able to find nest sites in both small and large trees, large birds need large diameter trees in which to excavate nesting cavities. In addition, large snags usually stand longer than smaller ones. Emphasis is often placed on managing for viable woodpecker populations because their success will provide enough nesting sites for secondary cavity nesters (Table 13).

TABLE 13: NUMBER OF CAVITY TREES NEEDED TO SUSTAIN WOODPECKERS

Species	Territory Size (Acres)	Avg. nest tree ¹		(A) Cavity trees used, minimum (N)	(B) Pairs/100 acres, maximum (N)	(C) Cavity trees needed/100 acres ² (AxB) (N)
		DBH (in.)	Height (ft.)			
Red-Headed Woodpecker	10	20	40	2	10	20
Red-bellied Woodpecker	15	18	40	4	6.3	25
Yellow-bellied Sapsucker	10	12	30	1	10	10
Downy Woodpecker	10	8	20	4	10	40
Hairy Woodpecker	20	12	30	4	5	20
Three-toed Woodpecker	75	14	30	4	1.3	5
Black-backed Woodpecker	75	15	30	4	1.3	5
Northern Flicker	40	15	30	2	2.5	5
Pileated Woodpecker	175	22	60	4	0.6	2.4

Source: DeGraaf and Shigo, 1985.

¹ Larger trees may be substituted for smaller trees.

² Number of cavity trees needed to sustain population at hypothetical maximum level.

Snag Management Objectives: Forestry operations will continue to provide a supply of good to excellent quality snag trees, distributed over time and space in order to maintain self-sustaining populations of all cavity-dependent wildlife. In areas where good snag trees are lacking, poorer quality trees will be retained until better trees develop.

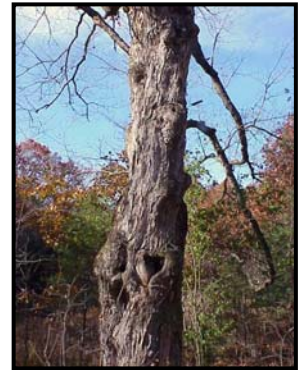
Recommended Practices for Snags:

- WHEN POSSIBLE, LEAVE ALL SNAGS WITHIN 100 FEET OF WETLANDS AND RIPARIAN AREAS.
- MAINTAIN A MINIMUM OF 6 SNAG TREES PER ACRE; AT LEAST 4 SHOULD BE > 24" DBH.
- AVOID DISTURBING SNAGS FROM APRIL TO JULY TO AVOID DISTURBING NESTING BIRDS AND DENNING MAMMALS.
- IF SNAGS MUST BE FELLED DURING MANAGEMENT OPERATIONS, THEN LEAVE THEM IN PLACE INSTEAD OF REMOVING THEM.
- WHEN POSSIBLE, IDENTIFY CURRENT OR POTENTIAL SNAGS THROUGH EXTERIOR SIGNS SUCH AS FUNGAL CONKS, BUTT ROT, BURLS, CRACKS, WOUNDS/SCARS FROM LIGHTENING, FIRE OR MECHANICAL DAMAGE, WOODPECKER HOLES OR CAVITIES, OR DEAD OR BROKEN LIMBS OR TOPS SO THAT THEY CAN BE RETAINED.

6.3.6.2 Den Trees

Den trees are living, hollow trees used by a variety of mammals including mice, raccoons, squirrels, and bears. In general, there are usually fewer den trees available in an area than could be used by wildlife because large (>15" dbh) rough or rotten trees are relatively rare.

Unlike cavity trees, which have central columns of decay, den trees are hollow or have large hollow limbs, but are still alive and vigorous. Den trees usually have easily visible openings in the sound wood. Some heavily-used den trees, such as those used by raccoons, are hardwoods with the top snapped off. Den trees usually have low commercial value, but their value to wildlife is extremely high and long lasting. It may take 100 years to develop large den trees, and once developed some trees (oaks, sugar maple) can live for several hundred years (DeGraaf and Shigo 1985). Once den trees die and fall to the ground, the remnant hollow log may last another 25 years, providing breeding habitat for a number of species including redback salamanders and ringneck snakes.



Den Tree Management Objectives: The Division will retain good to excellent quality den trees, distributed over time and space in order to maintain self-sustaining populations of all cavity dependent wildlife. In areas where good den trees are lacking, poorer quality trees will be retained until better trees develop.

Recommended Practices for Den Trees:

- RETAIN LIVE TREES WITH EXISTING CAVITIES AND LARGE UNMARKETABLE TREES.
- RETAIN 2 OR MORE TREES > 29" DBH PER 100 ACRES.
- LEAVE AT LEAST 1 TREE 15-29" DBH PER ACRE.
- LEAVE AT LEAST 1 LONG-LIVED TREE PER ACRE THAT SHOWS POTENTIAL FOR DEVELOPING INTO A DEN TREE (BROKEN TOP, LARGE BROKEN LIMBS, FIRE SCARS).
- LEAVE ALL DEN TREES WITHIN 100 FEET OF A WETLAND AND WITHIN RIPARIAN AREAS.

6.3.7 Downed Woody Material

Downed woody material refers to slash, logs, large and small limbs, stumps, and upturned tree roots that accumulate on the ground either naturally or through forestry operations. Downed woody debris provides food, cover, and nursery habitat for a range of flora, fauna, and fungi. Downed woody material provides critical wildlife habitat and is used for nesting, shelter, drumming, sunning, as a source of and place to store food, and as natural bridges. The specific value of downed woody debris depends on the physical distribution, amount, size, degree of decay, and orientation of debris relative to slope and exposure (Flatebo et al., 1999). Decaying logs also serve as nurse-trees for seedlings and colonization sites for fungi. Too much or too little downed woody material can be detrimental to wildlife. In general, it is best to retain or produce downed woody material that is distributed similarly to what would occur naturally.

Logs are generally considered to be the most valuable downed woody material because of their slow decay and longer persistence. Long logs >16" dbh are especially important wildlife habitat features. As logs age and decay, their role as wildlife habitat shifts. Logs supported by branches provide shelter, feeding, and display sites for a variety of birds and mammals. As the log settles to the ground and continues to decompose it may be used by small mammals, snakes, toads, and salamanders for shelter, food, and travel. Large logs with hollow portions may be used as den sites by larger mammals.

Downed Woody Material Management Objective: The Division will continue to maintain a range of sizes and types of downed woody material and retain or provide downed woody material in sites where it is lacking.

Recommended Practices for Downed Woody Material:

- IF SNAGS MUST BE FELLED DURING MANAGEMENT OPERATIONS, LEAVE THEM IN PLACE.
- AVOID DAMAGING EXISTING DOWNED WOODY MATERIAL DURING HARVESTING, PARTICULARLY LARGE (>16 INCH DBH) HOLLOW LOGS AND STUMPS.
- WHEN POSSIBLE, LEAVE AT LEAST 4 LOGS OF DECAY CLASS 1 AND 2 PER ACRE (FIGURE 11); AT LEAST 2 OF THESE LOGS SHOULD BE >12 INCH DBH AND >6 FEET LONG. HOLLOW BUTT SECTIONS OF FELLED TREES CAN BE USED.
- RETAIN AS MANY LOGS AS POSSIBLE OF CLASSES 3, 4, AND 5 (FIGURE 11)
- ON SLOPES, ORIENT LOGS ALONG CONTOURS AND PLACE AGAINST STUMPS WHEN POSSIBLE.
- IN CLEARCUTS, LEAVE SLASH ON AT LEAST 10% OF THE SITE SCATTERED IN PILES OR ROWS.
- DO NOT ADD DEBRIS TO STREAMS AND AVOID DISTURBING WOODY MATERIAL ALREADY IN STREAMS.

6.3.8 Woodland Raptor Nests

Hawks, owls, falcons, and vultures are known as raptors. There are 19 species of raptors that breed in New England, 16 of which are known or potential breeders on the Ware River watershed (Table 14).

TABLE 14: ACTUAL AND POTENTIAL BREEDING RAPTORS ON WARE RIVER WATERSHED

Species	Breeding Status	Nest Site Selection
Turkey Vulture	Breeder	Rocky outcrops, ledges, cavities
Osprey	Potential Breeder ¹	Stick nests in trees, snags, poles
Bald Eagle ²	Potential Breeder	Stick nests in living trees
Northern Harrier ²	Potential Breeder	On ground, over water
Sharp-shinned Hawk ²	Potential Breeder	Stick nest on tree limb-usually conifers
Cooper's Hawk ¹	Potential Breeder	Stick nest (may use old crow nest) on horizontal branch in hardwood or conifer
Northern Goshawk	Breeder	Stick nest (used or new) in hardwood
Red-shouldered Hawk	Breeder	Stick nest (new) in tall tree
Broad-winged Hawk	Breeder	Stick nest in tall tree
Red-tailed Hawk	Breeder	Stick nest in oak/white pine
American Kestrel	Breeder	Cavity, nest box
Barn Owl ²	Non-Breeder	Cavities, buildings, artificial
Screech Owl	Breeder	Cavities and woodpecker holes (Pileated/Flicker)
Great-horned Owl	Breeder	Cavities, old crow, hawk, or heron nests
Barred Owl	Breeder	Large natural cavities or old bird nests
Long-eared Owl ²	Potential Breeder	Old crow/hawk nest or natural cavity
Saw-whet Owl	Breeder	Natural cavity or woodpecker hole
Short-eared Owl	Non-Breeder	Open fields, heath on Cape/Islands
Peregrine Falcon	Non-Breeder	Cliffs, tall buildings, urban areas

Source: adapted from DeGraaf and Rudis 1986

¹Potential breeders are raptors not known to be currently breeding within the Ware River watershed, but given the bird's range and habitat requirements they could breed there presently or in the future.

²Listed with the Massachusetts Natural Heritage and Endangered Species Program as an endangered, threatened or special concern species.

Most raptors are predators and feed upon birds, mammals, fish, amphibians, insects, and snakes. While most raptors will eat a variety of animals, some species like the osprey have much narrower food requirements. Compared to other birds, raptors require relatively large home ranges (60 - >900 acres) in order to meet their food and nesting requirements. Raptor nests are widely dispersed across the landscape in a variety of habitats and forest conditions.

Some raptors will build a new nest each year within their territory, while other raptors will use the same nest for a number of years or claim the nest built by another species. Raptor nest trees must be large and strong enough to support nests ranging from 18 inches in diameter (broad-winged hawk) to over 3 feet (bald eagle, northern goshawk) (Flatebo et al., 1999). Large-diameter broken stubs, closely spaced branches halfway up large white pines, and 3-pronged main forks of mature hardwoods are most frequently used by stick nest building raptors. Preserving existing nests and potentially good future nest trees will help maintain raptor populations in an area over a long period.

Many raptors nest early in the year. By February-March, most great-horned owls and some red-tailed hawks and barred owls are incubating eggs. Most other raptors will be incubating by May. Nesting raptors can be vulnerable to human disturbance. There is a wide range of tolerance depending on the species. Some intolerant species (such as bald eagles and goshawks) may abandon the nest during the early weeks of incubation. Repeated flushing of the incubating bird from the nest may also subject the eggs to fatal chilling or the young to predation.

Identifying active nests is critical to ensuring their protection and establishing a buffer zone to minimize disturbance. The easiest, and unfortunately most infrequent, way to detect active nests is to see

birds in or around the nest. However, active nests can be identified when no birds are visible by looking for the following indicators:

- Prior to egg-laying, some raptors decorate the nest with fresh branches, usually from a conifer.
- After hatching, whitewash (excrement), regurgitated pellets, and prey remains may be found on the ground near the nest tree.
- Raptor nests can be distinguished from squirrel nests by their shape (squirrel nests are saucer-shaped) and lack of leaves (squirrel nests are made mostly of leaves).

Woodland Raptor Nests Management Objective: The Division will maintain suitable nesting sites for woodland raptors across the landscape over time and will avoid disturbing nesting pairs of raptors.

Recommended Practices for Woodland Raptor Nests:

- CONTACT DIVISION'S WILDLIFE BIOLOGIST WHEN PLANNING FOREST MANAGEMENT ACTIVITIES IN THE VICINITY OF A BALD EAGLE NEST.
- INSPECT MATURE WHITE PINE AND HARDWOOD TREES FOR LARGE STICK NESTS WHEN CRUISING TIMBER STANDS. WHEN POSSIBLE, DO NOT CUT TREES CONTAINING LARGE STICK NESTS AND HARDWOODS WITH 3-PRONGED FORKS.
- MAINTAIN AN UNCUT BUFFER OF AT LEAST 66 FEET AROUND ACTIVE RAPTOR NESTS AND RETAIN 65-85 PERCENT CANOPY CLOSURE WITHIN 165 FEET OF LARGE STICK NESTS AND HARDWOODS WITH 3-PRONGED FORKS.
- IF AN ACTIVE RAPTOR NEST IS LOCATED BEFORE OR DURING A SCHEDULED HARVEST OPERATION, MAINTAIN AN UNCUT BUFFER OF AT LEAST 66 FEET AROUND THE NEST TREE, AND DO NOT HARVEST WITHIN 330 FEET OF THE NEST DURING APRIL-JUNE.
- IF AN ACTIVE RAPTOR NEST CAN BE POSITIVELY IDENTIFIED AS BELONGING TO A COMMON OR TOLERANT SPECIES (I.E. , RED-TAILED OR BROAD-WINGED HAWK), THEN HARVESTING SCHEDULES AND BUFFER ZONES MAY BE RELAXED.
- RETAIN OCCASIONAL SUPER CANOPY PINES NEAR THE RESERVOIR SHORELINE AS POTENTIAL FUTURE NEST TREES FOR BALD EAGLES.
- FOLLOW APPROPRIATE SNAG TREE MANAGEMENT GUIDELINES.

6.4 Assessment of Impacts of Planned Watershed Management Activities on Wildlife

The management activities described in this plan will have various impacts on the wildlife community at the Ware River. Most impacts will be a result of habitat changes or modifications. The forest management approach described in this plan has landscape level effects, although individual changes at any given time will be localized and relatively small.

The amount and types of habitat at the Ware River have been dynamic since early colonial times. Once covered by primeval forest, a majority of the land in the Ware River watershed was cleared for agriculture during the 18th and 19th centuries. This trend persisted until about 1840 when 75 percent of the arable land was in pasture or farm crops (DeGraaf et al., 1992). The next 100 years was another period of dramatic change as most of the farmland was abandoned and new forest invaded the former fields.

Dramatic changes in the wildlife community accompanied these broad landscape changes. Some species thrived and expanded their range, while others were temporarily extirpated or became extinct. When agriculture dominated the landscape, it is likely that numbers of black bears, wild turkeys, forest songbirds, and other species adapted to forested conditions were greatly reduced throughout much of their former range. Bluebirds were abundant during the agricultural period, but are now relatively uncommon breeders. Other open habitat species (bobolinks, vesper sparrows, and golden-winged warblers) that were also common during the heavy agriculture periods have also declined as their available habitat reverted to forest cover.

Most of the undeveloped land in the Ware River watershed today is forested. While the Division's management activities will alter habitat and wildlife species composition, probably the most significant impacts to the wildlife community have been these large regional changes in land use. In addition, continued human population expansion in central Massachusetts has meant the loss of more and more open space as it is converted to residential housing. Further, large-scale disturbances to the landscape such as the 1938 hurricane and periodic fires have shaped the existing wildlife community.

For the most part, the Division's forests are multi-aged, multi-species. Future management will be focused on encouraging regeneration and improving the health and vigor of the forest. While the management techniques used to reach these goals will not be as dramatic as previous landscape-level events, it is important to understand how this management will affect the habitat and wildlife communities on the watershed.

6.4.1 Three-Strategy Forest Management: Impacts to Wildlife

The Division's primary long-term forest management goal is to establish and/or maintain a forest cover of diverse native tree species of many different age classes on a majority of its land holdings in order to protect water quality. This will be accomplished through uneven-aged forest management, even-aged forest management, and the establishment of forest reserves. Harvest will be through selection of individual trees or small groups up to 2 acres in size. In limited areas, larger openings up to 10 acres will be created. As a result, the wildlife community on Division land will be dominated by species adapted to these forest conditions. Uneven-aged management is the best technique for preserving individual trees of high wildlife value such as dens, nests, roost, and mast producers (Payne and Bryant, 1994). In addition, uneven-aged management maximizes vertical diversity. Even-aged management can be beneficial to a variety of wildlife species, and forest reserves can also play an important role in maintaining biodiversity.

Meeting this primary goal will mean wildlife communities on Division land will be dominated by species adapted to a variety of forested conditions. Those species requiring early-successional non-forested habitat will be less common and restricted to those limited areas where this type of habitat exists. Open, non-forested habitat will be maintained on a small percentage of the Division's land, primarily associated with fields, open land associated with developed areas, beaver impoundments, and openings deliberately created for biodiversity. In general, wildlife species adapted to forest cover should benefit the most from the Division's land management plan for its Ware River watershed properties.

6.4.1.1 Strategy One Areas

Strategy One areas will not be actively managed and include wetlands and hard-to-access parcels. These areas total approximately 5,700 acres and are located across the watershed. Because these areas are essentially unmanaged, they can be classified as forest reserves. Forest reserves can serve a variety of

useful functions, including having unique aesthetic and recreational value. In addition, reserves can function as reference sites in which to measure the effects of forest management on various wildlife communities. Finally, forest reserves are critical when addressing biodiversity. Setting aside areas where natural processes can proceed without human interference is necessary in order to fully address biodiversity because some birds, invertebrates and mammals depend on old-growth forests.

Locations of forest reserves created on the Ware River are largely related to hydrologic and/or topographic features of the landscape, and thus are not necessarily representative of the all habitat types present on the watershed. Unmanaged areas at the Ware River are confined to wetlands and areas where active forest management cannot occur. Therefore, protection is biased towards these habitats and the species that occur in them. In order to assure that all potential aspects of biodiversity are addressed, forest reserves need to be representative of the ecosystems present.

Even though Strategy One areas were selected using specific criteria, they still represent areas of biological importance. Many rare and endangered species in Massachusetts rely on wetlands during their life cycle. Setting aside wetland habitat into reserves should benefit these species. In addition, creating areas of old growth forest should benefit a wide variety of wildlife species.

6.4.1.2 Strategy Two Areas

In Strategy Two areas, uneven-aged silvicultural techniques will be used to create gaps and openings up to ¼ acre in size. Approximately 3,700 acres will be managed under Strategy Two, and these areas include buffer strips along riparian areas and roadsides. Management techniques used in Strategy Two areas include single-tree and small group selection, as well as an extended version of the shelterwood method of regeneration. The primary silvicultural method proposed during this 10-year plan within Strategy Two areas will be single tree selection creating openings up to ¼ acre in size. As mentioned above, single tree selection essentially maintains an intact forest canopy and is well suited to regenerating shade-tolerant tree species. Those wildlife species requiring continuous forest canopy and large tracts of unbroken forest habitat are favored by single tree selection because the integrity of the habitat is not altered. Many Neotropical migratory forest songbirds (e.g., forest warblers, wood thrush, and ovenbird) are edge sensitive species that require unbroken tracts of forest to successfully breed. When single trees are removed from the forest, no edge or transition habitat is created and the forest interior is maintained. While this will benefit these edge sensitive species, those species that rely on early-successional habitats (e.g., Eastern towhee, chestnut-sided warbler) will be limited to areas where these habitats exist.

6.4.1.3 Strategy Three Areas

In Strategy Three areas, a range of forest management techniques will be employed from single-tree selection to small group openings (up to 2 acres) to even-aged forest management. Even-aged management will be used to create forest openings 5-10 acres in size depending on whether reserves are left. Approximately 13,500 acres fall under Strategy Three areas and these include plantations, poor quality stands or poorly-sited stands, as well as more typical “site-suited” forest stands.

6.4.1.3.1 Group Selection

Much attention has been focused recently on the potential problems of forest fragmentation in the northeast. Most of this effort has centered on Neotropical migratory birds and the continued decline of

some species. It has been shown that area-sensitive songbirds do not reproduce well along edge habitats (Sullivan and Brittingham, 1994). In most cases, when trying to conserve edge-sensitive species, it is recommended that extensive areas of contiguous forest are maintained and the amount of edge habitat minimized. Although the Ware River watershed is located within a fragmented landscape, the Division owns large areas of contiguous undeveloped habitat. It is hard to speculate how much impact Division forest management activities that remove 2 or more acres of trees will have on edge-sensitive species. Alterations to Division forested land is not analogous to what would occur if the same land were developed for residential housing or agriculture. However, since the Division proposes to use group selection (up to 2 acres) and/or even-aged management to treat a majority of their stands, it is prudent to consider the impact of these practices on wildlife communities.

The most influential factor associated with this type of silviculture would be the introduction of edge effects. Many studies have documented the reduced nesting success of songbirds near forest edges when compared to the interior (Wilcove, 1988). This reduced success is a result of nest predators (e.g., blue jays, chipmunks, raccoons, crows) and/or nest parasites (e.g., brown-headed cowbird). In addition, rates of cowbird parasitism increase near openings within large forest tracts (Wilcove, 1988). Initially it might appear that edge effects would be limited to isolated woodlots surrounded by houses or barren land. Division land within the Ware River watershed is almost exclusively forested, and most of the forest is more than 60 years old. Unfortunately, edge effects are applicable to forest ecosystems because even small openings within forests create edges.

Although most changes in vegetation caused by group selection extend only 30-100 feet into the forest, increases in nest predation and parasitism may extend as far as 1,000-2,000 feet into the forest. Therefore a small number of openings in the forest could impact a large area. Careful placement and concentration of openings would help minimize edge effects by leaving large areas of mature forest intact.

Impacts of fragmentation on mammals are less well known. It is likely that species most sensitive to forest fragmentation were extirpated long before they could be studied. Mountain lions, wolves, elk, and woodland bison have been gone from the watershed for decades. As a result, those mammals left within the watershed are the ones adapted to surviving in fragmented, human-altered landscapes. It is likely that the main limiting factor on large mammal populations is human disturbance and not fragmentation.

Openings within forests do benefit some wildlife species, which depend on herbaceous and early-successional openings. Wild turkey, ruffed grouse, Eastern towhee, red-shouldered hawk, and white-tailed deer will benefit from the proposed openings that will be created. Forest openings will allow for denser ground cover, increased light, and a more open canopy.

6.4.1.3.2 Non-harvest Cutting on Sensitive Sites

On some sensitive areas where tree cutting still needs to occur (e.g., inaccessible pine plantations, shorelines, hurricane exposed areas), the Division proposes to cut trees but not remove them. This would enhance forest regeneration without negatively impacting the sensitive sites. This type of management may be used on a limited portion of Division land. Because this is being proposed on such a limited area, it will have little impact on wildlife species at the landscape level.

The Division may also conduct non-removal harvest of trees along riparian wetlands to increase light and stimulate regeneration. Cut trees will be left in place along the riparian area. This will add coarse woody debris, providing additional cover and nutrients for forest floor wildlife. The additional

light will allow for a greater diversity of understory trees and ground cover. This will benefit wildlife species that utilize a dense understory layer of vegetation.

This management practice could have potential negative impacts on the wildlife community depending on where the harvesting occurred and how many overstory trees were removed. Removing a large number of deciduous trees along the riparian zone could negatively impact species using wooded stream courses as travel corridors. However, if single trees or small groups were removed, these impacts would likely be minimal. On some streams there is almost continuous conifer (hemlock) cover which characteristically has little understory regeneration. This habitat type is uncommon on the watershed and provides unique habitat for a variety of wildlife. Removing trees in these areas could alter the microclimate of the area and have potentially negative effects on the wildlife and stream community. The hemlock woolly adelgid will likely bring about some of these effects with or without intervention.

When harvesting trees along the riparian area it is important to try to save cavity or potential cavity trees. Cavity trees along riparian wetlands are extremely valuable to a range of wildlife species.

A final consideration regarding this management technique would be to recognize that stimulating regeneration and new growth along riparian wetlands will be beneficial to beaver populations. Availability of a winter food supply is an important factor affecting beaver distribution in areas where stable water levels are possible.

6.4.1.3.3 Removal of Plantations

The full overstory removal of plantations results in dramatic and immediate changes with regards to wildlife habitat and species. Full overstory removal is essentially even-aged management and results in both positive and negative impacts to wildlife. In general, removing the overstory will provide early-successional habitat that is utilized by a variety of species. Early-successional species will particularly benefit from this management because the larger stand size will attract and sustain larger populations of those species. Those species requiring continuous forest canopy will be negatively impacted by these treatments. In addition, species utilizing conifer-dominated habitat (e.g., red squirrels, some neotropical migrants, nesting raptors) may be displaced.

6.4.1.3.4 Effects of Even-Aged Management on Wildlife

Even-aged forest management is the best technique for producing and sustaining large amounts of early-successional forested habitat. Early-successional forested habitat provides a unique set of characteristics that are beneficial to a variety of wildlife species. Some of these species depend exclusively on this type of habitat (for a complete description, see section 7.5, Maintenance of Early-successional Habitat for Landscape Diversity). Further, no breeding birds are restricted to uneven-aged forest habitats, while many species are restricted to even-aged habitats, particularly regenerating or sapling-sized stands (Thompson and DeGraaf, 2001).

The Division proposes regenerating approximately 135 acres per year in Strategy 3 areas. The resultant habitat should greatly benefit those species requiring early-successional forested habitat. For example, New England cottontail rabbits, prairie warblers, woodcock, and bobwhite quail are dependent on this type of habitat and should benefit from its creation. In order to maximize the potential benefit of creating early-successional habitat, openings could be clustered to simulate a much larger opening.

6.4.2 Considerations during Timber Marking, Harvesting, and Other Land Management Activities

While careful planning and preparation can mitigate many of the potentially negative impacts on wildlife resources, some specific impacts or events cannot be discovered until operations begin in the field. Locations of active raptor nests, quality den and snag trees, and seeps may not be discovered until foresters begin marking individual trees in a lot. It is during these detailed lot inspections that some of the specific wildlife habitat management recommendations can be implemented. In addition, broader considerations such as timing of operations, harvesting techniques, record keeping, and other miscellaneous considerations should be addressed.

6.4.2.1 Timing of Operations

The timing of land management activities can have a dramatic impact on wildlife species. Some species (e.g., bald eagle, great-blue heron, and coyote) are extremely sensitive to human disturbance and may abandon or forgo breeding when repeatedly disturbed. Fortunately, nesting or denning areas of some sensitive species are already known, or can be easily identified. Great-blue herons nest in visible colonies, usually in dead snags over water. In addition, bald eagles build large stick nests that are easily seen and may be used for many years. However, for most other species, their nest, burrow, or den is well hidden and might not be discovered until an operation had already begun. Luckily, most wildlife species nest or den during the spring and early summer when land management activities are restricted.

Division personnel will notify the wildlife biologist when land management activities have clearly disrupted a rare or uncommon species' breeding activity. The Division wildlife biologist will assess the nature of the nesting/denning activities and determine what species is involved, what stage of breeding is occurring (courtship, incubation, brooding, etc.) and how the animals responded to the initial disturbance. The Division will determine what options will be used to mitigate and avoid further disturbance during the remainder of the breeding season.

Land management activities conducted at other times of the year may unknowingly impact wildlife species, and efforts will be made to reduce these conflicts. Maintenance (mowing, burning, etc.) of fields and open areas should only be done in early spring (March/April) or after August 1 to avoid disrupting nesting birds and mammals. No activity should occur in or near seeps during winter. If possible, winter activity in and around identified wildlife wintering areas should follow the guidelines in section 6.3.4.

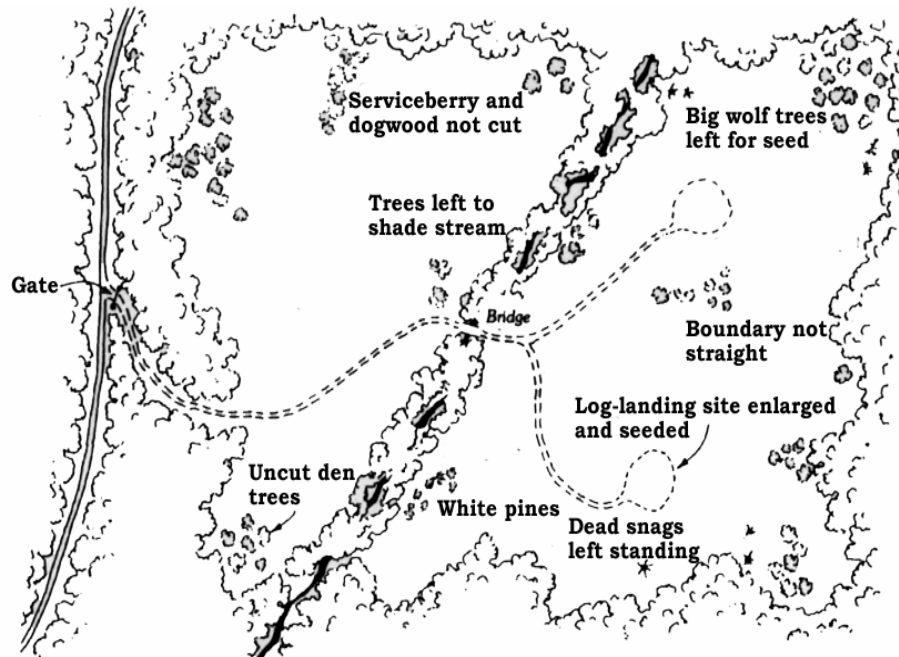
In some cases, activity during certain times of the year is preferred. Working around vernal pools is often best during winter when frozen/dry conditions minimize rutting and disruption of the forest floor. Further, logging during the fall and winter usually has minimal impact on most wildlife habitats and may actually benefit some animals by providing additional browse and cover.

Land management activities conducted at any time of the year have the potential to disrupt some wildlife species. This disruption is usually small in scale and centered in the vicinity of the logging operation and the benefits derived from actively managing the watershed lands may outweigh the localized disruption. Nonetheless, the Division will continue to gather data on critical and sensitive wildlife and their habitats on the watershed, and will adjust the timing or location of logging operations as necessary in order to avoid impacts on special concern species.

6.4.2.2 Group Selection Considerations

Certain techniques and considerations can be used to enhance the area for wildlife uses when forestry operations use group selections to remove trees in openings 1 acre or greater in size. With proper planning, harvesting operations can be conducted while still maintaining snags, den trees, and mast producing trees within the opening (Fig.12). In addition, creating an irregular, feathered border will help reduce nest predation and parasitism.

FIGURE 12: FOREST OPENING PLACED WITH WILDLIFE CONSIDERATIONS



6.4.2.3 Logging and skid roads

Access roads are used by the Division to collect water samples, remove wood, control fires, maintain watershed structures, and aid in navigation. Most Division roads within the watershed are narrow, grassy woods trails often referred to as logging roads. While roads are necessary to the Division, they can also act as barriers to animal movements and fragment the forest.

The effect of forest roads on wildlife and biodiversity depends on the size, type and location of the road. The frequency with which a road is used and its proximity to sensitive resources also determine its impacts. Roads effectively create an edge habitat that benefits some species, but has negative effects on species sensitive to disturbance or predators. Roads are often used by some wildlife species as travel lanes, but they may impede the movements of other species that require continuous vegetative cover. Roads may also fragment the forest and isolate individuals or populations.

Constructing and maintaining forest roads on Division property constitutes a relatively permanent change in the habitat structure of the area. There is little concern about direct mortality on wildlife populations because traffic on Division roads, particularly at night, is minimal. A strip of dirt or gravel under an open canopy can serve as a physical or psychological barrier to animal movements, however, including small mammals, amphibians, and invertebrates (deMaynadier and Hunter, 2000).

When logging roads, skid trails, and landings are being planned, certain design features can be incorporated to minimize wildlife impacts. Logging roads/skid trails should avoid vigorous patches of shrubs. New logging roads should be minimized and existing roads should be upgraded instead if possible. Roads should be as narrow as possible, ideally one-lane with occasional turnouts. Circular routes should be avoided; a cul-de-sac design is better. When possible, abandoned logging roads, skid trails, and landing sites should be seeded with a grass-legume mixture. Road intersections should be angled to limit line of sight.

6.4.2.4 Record Keeping

Division foresters, rangers, and other natural resource staff spend a large amount of time walking, observing, and assessing lands within the Ware River watershed. It is likely that they may observe significant wildlife or important wildlife habitats. Because of the size of the watershed, these anecdotal observations are an important source of biological information, and may be valuable in determining how to avoid or mitigate potential wildlife impacts of future land management activities. These observations must be reported to the Division wildlife biologists so that records may be routinely maintained and updated.

6.4.2.5 Miscellaneous Considerations

The Division's silvicultural practices often include cutting trees with weak crown forms that are more susceptible to damage. Some of these trees have wildlife value, and Division foresters will continue to leave some of these trees uncut. For example, trees growing on an angle following partial windthrow serve as travel routes for arboreal mammals from the ground to the forest canopy. In addition, older trees with large stocky limbs often have protected crotches that are used by nesting birds and mammals. These trees also typically have a high potential for cavity formation. While it is not necessary to maintain all examples of these trees, it is important to retain some during harvesting operations.

Particular combinations of trees species are also valuable to wildlife. For example, mature oak trees within hemlock or other conifer stands provide food resources within wildlife wintering areas. Small pockets of hemlock within hardwood stands can provide important wildlife cover. Both of these habitat conditions should receive special treatment when feasible.

6.5 Wildlife Populations Requiring Monitoring and/or Impact Control

The Division's primary responsibility is to the long-term protection of the drinking water supply provided from its watersheds. Most wildlife populations on these watersheds are controlled by a combination of natural predation and competition, and their potential impacts on water resources and other Division interests are therefore limited. However, populations of some species are primarily controlled through human intervention (hunting, trapping) and impacts on water quality or other resources are possible if this population control is reduced (Table 15). In general, it is the Division's policy not to interfere with natural wildlife activity. However, when wildlife populations or activities significantly impact either water quality or the integrity of watershed structures or resources, then the Division must take an active role in mitigating those damages. The species of concern and their associated risks are discussed below.

TABLE 15: POTENTIAL WILDLIFE IMPACTS OF SPECIAL CONCERN.

Species	Impact on Division Resources, Structures, and/or Water Quality
Beaver	Can cause damage to watershed structures and property; can negatively impact water quality depending on their location and site conditions
White-tailed deer	Can alter diversity and abundance of tree regeneration
Moose	Can alter diversity and abundance of tree regeneration

6.5.1 Beaver

6.5.1.1 General Comments

Beaver can dramatically alter their surrounding habitat, which in turn can affect other wildlife species and humans. Beaver have been linked to water-borne pathogens and are potential carriers of both *Giardia spp.* and *Cryptosporidium spp.* (MDC, 1999). In addition, beaver can cause localized damage to roads, culverts, and trees, although the habitat they create is seen as beneficial to a variety of wildlife species. Whether any given beaver colony is seen overall as beneficial or detrimental depends on various factors including location in the watershed and the structures or the resources affected. Division policy regarding beaver takes into account the variety of situations that may arise and applies solutions as needed to offer the best long-term remediation. Because beaver issues can become quite controversial, it is important to discuss and highlight the range of potential beaver impacts on a variety of resources.



6.5.1.2 Beaver Induced Alterations of Riparian Systems

Beaver are one of the few wildlife species that have the ability to dramatically alter the surrounding habitat to their benefit. These habitat alterations can have potentially substantial impacts on the ecosystem. Changes in vegetation, biotic and abiotic features of the wetland and downstream water bodies, and impacts to other organisms may result. Riparian areas, particularly along second- to fourth-order streams and adjacent low-lying areas are often colonized by beaver (Hammerson 1994). The presence or absence of beaver in an area or region can have a dramatic impact on the predominant vegetation. For example, in West Virginia, the widespread swamp forests common in the early 1900s were most likely the result of the eradication of beaver from the state by the early 1800s (Land and Weider, 1984, *in* Hammerson 1994). Except at beaver-occupied sites, Division-owned riparian areas are primarily forested with a variety of tree species. It is interesting to note that these forested wetlands in Massachusetts may be an artifact of the beaver's eradication from the state by the late 1700s until their eventual return in 1928 (1950s at Quabbin). The absence of beaver allowed these riparian areas to grow maturing forests. Recent changes to the riparian landscape caused by expanding beaver populations may appear even more dramatic as a result.

The Division's primary interest is to preserve and protect water quality within the water supply reservoirs, and riparian areas are a critical component of that protection. As a result, it is helpful to summarize the impacts of beaver on the biotic and abiotic components of riparian ecosystems in order to address potential negative impacts from their occupation of riparian areas.

One of the most important factors related to changes in the environment is the structural integrity of beaver dams. Many of the effects associated with beaver occupation of riparian zones are contingent on the longevity and stability of the dam itself. Dams that continually wash out may cause water quality problems associated with flooding and the sudden release of sediment and accumulated nutrients. It is usually dams on larger streams (above fourth-order) that are prone to wash-outs (Naiman et al., 1988). Most of the streams within the Ware River watershed are first- to second-order streams, although there are larger streams (East and West branches of the Ware River) that are fourth- to fifth-order streams. Any beaver dams located on these higher order streams are much more prone to wash-outs.

The beaver's role in pathogen transmission is addressed separately (see report, *Quabbin and Wachusett Watersheds Aquatic Mammal Pathogen Control Zone Report, 1999*), and beaver are intensively managed by the Division when colonies are located within the defined Pathogen Control Zones at Quabbin or Wachusett reservoirs. There is no Pathogen Control Zone at the Ware River because the Ware River watershed lacks a terminal reservoir and its water is diverted to either Quabbin or Wachusett Reservoirs. Beaver located on the Ware River watershed (unless otherwise determined) are not assumed to be contributing to water degradation with regards to pathogen transmission or amplification.

The role of beaver in riparian systems was reviewed and is summarized below. The effects of beaver on riparian vegetation, water quality parameters, and ecology are discussed.

6.5.1.2.1 Beaver Impacts on Riparian Vegetation

Beaver are strictly herbivores and have been described as choosy generalists (Novak, 1987). Beaver are also central place foragers because they return to their lodge or bank den after feeding (Naiman et al., 1988). This is an important behavioral trait and as a result, beaver foraging is restricted to a relatively narrow band of forest surrounding their pond (Johnston and Naiman, 1990). One study indicated that beaver fed preferentially on a small number of deciduous species and the number of stems cut declined sharply as distance increased from the pond (Donker and Fryxell, 1999). Barnes and Mallik (2001) found that 91% of all beaver cut stems were within 20.1 meters of the pond shoreline. Beaver will cut and consume a variety of woody vegetation in addition to feeding on aquatic vegetation during the spring and summer. Beaver have a strong preference for certain species, particularly members of the aspen family.

When beaver colonize a new riparian area, several important events take place. Typically, a dam is constructed across a stream, raising the water level. The raised water level kills trees within the flooded zone. In addition, beaver cut down trees along the shoreline. Although a substantial number of trees may be lost due to flooding, the wetland continues to be buffered by a forested habitat. The forested zone has been pushed back to the new high water level, as opposed to lining the original stream bank. Along the shoreline, some canopy trees are killed or toppled by beaver, allowing more light to reach the forest floor. Increased light from overstory removals, along with a decrease in competition for water and nutrients, will stimulate regeneration and a release of the forest understory (Johnston and Naiman, 1990). The light penetration may be sufficient to allow regeneration of shade-intolerant species (Donker and Fryxell, 1999).

The amount of canopy being removed along the shoreline can vary. After 6 years of continuous occupation, one study site had a 43% reduction in basal area of stems >2 inches dbh within the shoreline area (Johnston and Naiman, 1990). Other studies have indicated that perceived damage and actual damage to forest resources may be quite different. King et al. (1998) described the effect that beaver in a

wetland in the southern United States were having on the forest. In this case it was determined that although tree damage adjacent to the wetland was highly visible by casual observation, beaver were having little impact on landscape-level tree survival.

In some cases where the overstory is primarily comprised of aspen or poplar, a majority of the overstory may be removed, and the riparian area may go through a shrubby/woody stage until non-browsed species grow and overtop the shrub layer. On the Ware River watershed, aspen species are a relatively minor component of forested riparian areas. Most riparian areas consist of a diversity of species, making it less likely that all trees will be removed, although the shrubby component of the riparian area may become more dominant as some canopy trees are lost. Beaver-induced changes to vegetation along riparian zones can be quite dramatic when compared to conditions prior to beaver occupation. The primary result of these changes will be a shift in the species composition before and after beaver occupation. In summary, the riparian wetland, although different following beaver occupation, is still buffered by a partially forested habitat that may contain a larger shrubby component.

6.5.1.2.2 Beaver Impacts on Water Quality

As mentioned previously, the Division does not manage beaver within the Ware River watershed to control pathogen transmission. However, because beaver can alter the hydrologic regime of riparian areas, it is important to consider their impacts with regards to general water quality parameters. As mentioned previously, most streams within the Ware River watershed are low-order (first-to-third) systems, and thus beaver dams constructed in these sites are likely to exist in stable conditions for many years.

In many situations, beaver dams can transform a lotic (moving) system into a lentic (still) habitat that may resemble a lake or pond (Hammerson, 1994). Some important changes associated with this transformation include increased water depth, elevation of the water table, an increase in the wetted surface area of the channel, and increased storage of precipitation, which is more gradually released. In addition, the storage of precipitation can reduce variability in the discharge regime of the stream. In low-order streams there is a shift to anaerobic biogeochemical cycles in soil layers beneath the aerobic pond sediments.

Ponded areas behind beaver dams reduce current velocity, which decreases erosion and stabilizes streambanks (Brayton 1984, Hammerson 1994). In some western states beaver were introduced into riparian ecosystems with eroded streambanks and little vegetation along the shoreline (Brayton 1984). The result was a dramatic decrease in sediment transport downstream, streambank erosion was stabilized, and the diversity of vegetation began to increase (Brayton 1984). In addition, by slowing water velocity there is increased trapping of sediments behind beaver dams, and a resultant decrease in turbidity downstream (Brayton 1984, Hammerson 1994, Maret et al., 1987, Naiman et al., 1994, Naiman et al., 1988). Several studies have shown a substantial amount of sediment being collected behind beaver dams, ranging from 1.5-6 feet (Hammerson 1994, Meentemeyer and Butler 1999). Meentemeyer and Butler (1999) suggest that if beaver are eliminated from a landscape, basin sediment yields can increase dramatically. Having beaver present in a watershed can help minimize sediment transport and stabilize stream banks (Meentemeyer and Butler 1999).

Some important changes in the chemical and physical properties of the stream occur when an area is dammed. Generally there is a reduction in dissolved oxygen, aluminum, and sulfate, and an increase in pH, dissolved organic compounds, iron, and manganese (Smith et al., 1991, Hammerson 1994). Dissolved oxygen reduction is most likely the result of increased retention of organic matter and associated decomposition processes (which use oxygen) (Smith et al., 1991). By retaining large amounts

of sediment and particulates, beaver ponds can also trap nutrients associated with sediments, including phosphorus (Maret et al., 1987). Other studies have shown that beaver activities may increase concentrations of phosphorus within the impoundment (Klotz 1998). However, in these studies it is clearly shown that increased concentrations of phosphorus only occur for short distances downstream of beaver ponds before equilibrium processes reduce the concentration (Klotz 1998). Phosphorus is an important element in water supply reservoirs because it is often the limiting factor in the growth of aquatic plants and algae in reservoir systems (Lyons 1998). Thus, the more P that is available in the system, the greater will be the growth of algae.

A potential problem associated with beaver is the increase in dissolved organic carbon (DOC) within the beaver pond. Though DOC does not directly affect drinking water quality parameters, it is a water quality concern because increased DOC can increase disinfection by-products in chlorinated systems. DOC in beaver ponds increases for several reasons. First, a large amount of wood is transferred into the stream channel, either directly through cutting or indirectly through flooding. In addition, more leaves are collected within a pond than in a stream channel. The carbon turnover rate for this material is less in a ponded area than in a stream with flowing water (Hammerson 1994). Margolis et al., (2001) found average DOC concentrations 10 meters and 100 meters downstream of a beaver impoundment were significantly higher than DOC concentrations upstream of a beaver pond. Although increases in DOC are a potential concern, a recent study at Quabbin suggested that biological processes and the sheer size of the reservoir prevented these elevated DOC levels in the tributaries from reaching the intakes (Garvey 2000). In fact, this study suggests that algae are a much greater concern regarding disinfection by-products at reservoir intakes than elevated DOCs in watershed tributaries.

The overall effect of the ponding of riparian areas is the translocation of chemical elements from the inundated upland to the pond sediments or downstream. A portion of the chemical elements are transported downstream, while most are accumulated in the pond sediments and are available for vegetative growth if the pond drains and succession begins (Naiman et al., 1994).

6.5.1.2.3 Ecological Changes Associated with Beaver

As the beaver transforms the stream channel into a ponded area, various ecological changes result. The most immediate effect could be the potential loss of habitat for species either requiring large expanses of deciduous trees along a stream or those species living within the stream channel. Because a beaver dam influences only parts of a stream course, it is unlikely that beaver activity would result in the disappearance of species relying on wooded streams. In New York, experts agree that even after 30 years of expanding beaver populations, species or communities requiring wooded wetlands were probably not adversely affected on a regional or statewide level (Hammerson, 1994).

There is often a good deal of concern regarding the impacts of beaver impoundments on cold water fisheries. It is likely that beaver both enhance and degrade fish habitat. Hägglund and Sjöberg (1999) indicated that beaver enhance fish species diversity in Swedish streams. In addition, they speculate that beaver ponds serve as habitat for larger trout in small streams during drought periods. Snodgrass and Meffe (1998) indicated that in low-order streams, beaver had a positive effect on fish species richness. However, on a landscape level, such positive effects are dependent upon a dynamic pattern of beaver pond creation and abandonment over time.

The warming of stream water is often cited as a cause of concern regarding cold water fish habitat. A study done in Maryland and Pennsylvania reported that water temperatures were significantly warmer downstream of beaver dams during the fall, spring, and summer (Margolis et al., 2001). McRae

and Edwards (1999) indicated that large beaver impoundments would often warm downstream temperatures slightly, but they also served to dampen temperature fluctuations immediately downstream. In addition, when beaver dams were experimentally removed, the difference between upstream and downstream temperatures was unchanged, although in some cases, dam removal increased the warming rate of the stream (McRae and Edwards 1999). It has been suggested that in the absence of direct thermal inputs, ambient air temperature (not the presence of impoundments) is the single most important determinant of stream temperature (McRae and Edwards 1999).

The impacts on other organisms resulting from stream channel transformation by beaver are less well understood. For example, Russell et al. (1999) reported that species richness and abundance of amphibians were not significantly different among old beaver ponds, new beaver ponds, and unimpounded streams. Reptiles did show a difference among sites. Richness and total abundance of reptiles was significantly higher at old beaver ponds (Russell et al., 1999). Another study found no significant differences in overall herpetofaunal abundance between uninterrupted streams and beaver ponds (Metts et al., 2001). However, significantly more salamanders were captured at uninterrupted streams and significantly more anurans, lizards, and turtles were captured at beaver ponds (Metts et al., 2001).

Invertebrate communities exhibit strong ecological shifts as running water taxa are replaced by pond taxa when streams are impounded. This results in an increase in the number of collectors and predators and a decrease in the number of shredders and scrapers (Naiman et al., 1988). While total density and biomass may be 2-5 times greater in ponds than in riffles, the total number of species in ponds and streams appear to be similar (Naiman et al., 1988).

6.5.1.3 Summary

Beaver populations within the Ware River watershed continue to expand as beaver mortality rates remain low. As beaver continue to colonize riparian areas, it is important to recognize their role in hydrologic and ecological processes. A careful review of the literature would indicate that it is not the presence of beaver dams but their persistence through time that has the greatest potential impact on water quality. The results of one study suggested that beaver ponds could improve water quality if they were in the right locations (Maret et al., 1987). This study suggested that it was really the downstream channel that had the largest impact on water quality, as the authors state:

Our data illustrate the importance of location of beaver ponds along a stream in improving water quality. If water quality is to be maintained downstream from ponds and if nutrient export to a lake or reservoir is to be reduced, then the channel downstream from the pond complex must be stable or the pond complex must be located close to the lake or reservoir.

Most streams within the Ware River watershed are low-order (first to third), and beaver dams constructed across these streams have the strong potential for long-term stability and persistence. On those sites with historically unstable beaver dams or on particularly “flashy” streams, beaver control may be necessary to prevent water quality degradation associated with dam instability.

Some water quality parameters are modified when beaver construct dams in riparian areas. Generally, there is a reduction in dissolved oxygen, and an increase in dissolved organic carbon, pH, and iron. Some studies have suggested that these changes may carry at least 100 m downstream of an impoundment. There is also some evidence to suggest that beaver ponds (like most wetlands) may have a filtering effect that improves water quality by decreasing erosion, and trapping sediments, particulates, and nutrients. Changes to vegetation along the banks of beaver ponds result in a species shift away from

those species preferred by beaver to a larger proportion of woody shrubs and unpalatable or undesirable (by beaver) canopy trees. The more open canopy that results from beaver activity stimulates regeneration and increases habitat diversity.

Overall, there appears to be either no effects or positive effects on faunal species richness and diversity when comparing ponds to unaltered riparian wetlands. There are still site-specific situations where beaver will need to be controlled as detailed in the next section. Outside these specific situations where damage is occurring, there does not appear to be a need for the Division to focus beaver control efforts on a watershed basis. It should be highlighted that recreational trapping has historically been allowed on Division land within the Ware River watershed and continues to be a permissible activity. However, with recent restrictions on the types of traps allowed, there has been little watershed-wide trapping conducted since 1996.

6.5.1.4 Management Policy

Beaver management issues within the Ware River watershed can be broken down into two categories: Water Quality Protection and Damage to Structures or Resources. In both cases, the general policy of the Division is to evaluate and deal with beaver issues on a site-specific, case-by-case basis.

6.5.1.4.1 Water Quality Protection

There is consensus in the scientific community that beaver can play an important role in the transmission of harmful pathogens to humans through water supplies. The Division recently completed a report that summarizes these concerns and addresses management recommendations for beaver at both the Wachusett and Quabbin watershed reservoirs. For more detailed information regarding this see the report titled, *Quabbin and Wachusett Reservoirs Watersheds Aquatic Wildlife Pathogen Control Zones*. This report clearly defines a protection zone around each reservoir where beaver will be eliminated and excluded on a continual basis for water quality protection. That report does not address beaver management for water quality protection within the Ware River watershed. As discussed before, the Ware River watershed does not include a terminal reservoir. As a result, no defined control zone exists. If a situation arises where water quality is being threatened, then these situations will be handled on a case-by-case basis and mitigation may be required.

6.5.1.4.2 Damage to Structures or Resources

Watershed-wide beaver population control is not conducted by the Division. However, the following situations are examples where beaver activity may be discouraged, mitigated, or otherwise controlled:

- Beaver activity that threatens rare or uncommon plant or animal communities.
- Beaver activity that precludes the use of access roads necessary for watershed maintenance, management, or protection.
- Beaver activity that threatens the proper functioning or structure of dams, culverts, and other parts of the water supply infrastructure.
- Beaver dams on unstable or flashy streams with a history of, or potential for, regular washouts.

When there is a conflict with a beaver colony, the following procedure will be used to mitigate the damage. Division personnel encountering problem beaver sites should complete a Beaver Damage Observation Form and return it to the Division wildlife biologist and Quabbin/Ware River section superintendent. Upon review, the wildlife biologist and superintendent will decide the most appropriate control activity for each site. Guidelines for determining proper mitigation are discussed in the following section. Appropriate permits will be obtained when they are necessary (e.g., removing a section of dam to install a flow control pipe). Specific guidelines will be followed when lethal measures are determined to be the best alternative to alleviate the problem.

6.5.1.5 Guidelines for Determining Proper Mitigation for Problem Beaver

When a Beaver Damage Observation Form is received by the Division wildlife biologist and Quabbin/Ware River Superintendent, they will decide on the most appropriate control activity for that particular site. Options available include water level control devices, dam stabilization, culvert protection, or lethal removal. Site-specific control options will be chosen based on site conditions, history of the site, and type of damage occurring. The goal is to provide the most effective control possible that mitigates the problem. Lethal removal will be a viable option, but will only be used if all of the following criteria for the site are met:

- Beaver are causing documented (recorded observation, photographs, etc.) damage to Division infrastructure (roads, culverts, bridges).
- Other, non-lethal means (water level control devices, fencing, etc.) would not adequately mitigate the problem because of limitations in access, maintenance, or effectiveness.
- The Division property being damaged is essential and cannot be temporarily abandoned.
- Lethal measures can be implemented within appropriate laws and guidelines and without threat to the safety of the public, domestic animals or other wildlife.

When lethal measures are to be used, the following procedure must be followed:

- The above criteria must be documented (using Beaver Damage Observation Form) prior to any action.
- Whenever possible, local licensed trappers will be used to remove the animal(s) during regular state trapping seasons.
- Beaver will be removed through shooting (12 gauge shotgun), or live-trapping using Hancock, Bailey or cage traps and then shooting.
- All staff involved in lethal beaver control will have necessary training and licenses.
- Every attempt will be made to retrieve beaver carcasses, which will be buried at a suitable location.
- Personnel taking part in beaver control activities will take adequate precautions (washing hands/wearing rubber gloves) to prevent possible transmission of *Giardia* and *Cryptosporidium* and other pathogens.

- The supervisor in charge will document all actions and complete the proper form (Beaver Removal Documentation Form), copies of which will be sent to the Wildlife Biologist and Superintendent.

6.5.2 White-Tailed Deer



White-tailed deer populations are increasing in most of the northeast. There is growing concern about these increasing populations and their impact on natural resources (Healy 1999, Alverson and Walker, 1999, McShea and Rappole, 1999). Deer populations within Massachusetts are increasing in the central and eastern part of the state (MassWildlife, pers. comm.). White-tailed deer can thrive in suburban environments where there is abundant food, few predators, and enough wooded areas to provide cover. Coupled with expanding deer populations is increased fragmentation of the landscape that can create wooded reserves that in many cases prevent people from effectively hunting white-tailed deer populations. Even in areas where hunting is feasible, there is growing concern that both hunter interest and hunter recruitment is declining. In many situations, these circumstances can lead to overabundant deer densities.

Overabundant deer populations can influence the abundance of woody plant species (Walker and Alverson, 1997). In addition, intensive deer browsing may cause problems in regenerating particular species, such as oak. When deer populations are protected for many years and sustained at high densities, forest structure may be significantly altered, resulting in park-like stands with grass or ferns dominating the understory (Walker and Alverson, 1997). Situations like this have been documented on the Quabbin Reservation and in the Alleghany National Forest in northwest Pennsylvania (Walker and Alverson, 1997). Because deer hunting has been allowed on the Ware River watershed throughout Division control and before, such extreme conditions are unlikely to develop. However, if deer densities on Division land within the Ware River increase and remain high, then tree species preferred by deer may be affected, causing concern about both the density and the diversity of regeneration in forest stands.

Deer populations within Deer Management Zone 8 (encompassing most of the Ware River watershed) are estimated at 12-15 deer/mi². Deer populations within the Ware River watershed are estimated to be slightly higher, around 15-17 per mi² (MassWildlife, pers. comm.) due to large areas of quality habitat that has resulted from the Division's land management activities. There is growing concern about the declining hunter base and poor hunter recruitment that could impact both the number and distribution of deer kills within the watershed.

The Division's primary concern is to limit the impact of deer on tree regeneration and growth. The Division does not yet scientifically monitor forest regeneration or deer populations within the Ware River watershed. However, Ware River foresters routinely walk and inspect a variety of forest stands and sites within the watershed and make anecdotal observations about regeneration, including observed changes in diversity of species.

Given the trend of rising deer populations, shrinking hunting opportunities, and a declining hunter base, the Division recognizes the potential for some of its lands to experience overabundant deer populations. Although primarily focused on the impacts of overabundant deer on tree regeneration, the

Division also recognizes that other social issues related to overabundant deer may become more prevalent. These include increased deer/vehicle collisions and personal property damage. As a result, the Division will examine the feasibility of initiating long-term monitoring of both deer herd dynamics and tree regeneration across the watershed. Regeneration plots would be established and monitored to scientifically assess the impact of white-tailed deer browsing on tree regeneration and growth. In addition, surveys may be initiated to monitor deer population trends over time. The Division would collaborate with MassWildlife to design appropriate methods to index the deer population

6.5.3 Moose



Moose are North America's largest wild animal. An average adult moose weighs about 1,000 pounds and stands 6 feet at the shoulder. Moose and their ancestors originated in Siberia and made their way to North America across the Bering Sea land bridge. At the time of European settlement, moose were distributed from Alaska, across Canada into the northern United States from North Dakota east to Pennsylvania and all of New England, including Massachusetts. Moose also extended down the Rocky Mountains in the West. Temperature was probably the limiting factor in the southern distribution of moose in North America. Winter stress typically occurs when temperatures exceed 23°F and summer stress when temperatures are >59°F (Franzmann and Schwartz, 1997).

Moose were extirpated from Massachusetts by the early to mid- 1800s (Peek and Morris, 1998, Veccillio et al., 1993). A small number of moose escaped from a game preserve in Berkshire County around 1911 and may have persisted for several years (Veccillio et al., 1993). Most sightings during the next 50 years were probably northern vagrants. Since the late 1980s, the number of moose sightings has increased greatly (Peek and Morris, 1998). In 1998, the moose population in Massachusetts was estimated as at least 75 animals including cows with calves (Peek and Morris, 1998). Reasons for the increase in moose populations include the absence of predators, reversion of farms to forested areas, legal protection, increased wetlands from expanding beaver populations, and larger forest openings (Franzmann and Schwartz, 1997).

Moose populations continue to expand in Massachusetts. Division land within the Ware River watershed probably functions as a core habitat for moose populations given its large size and diversity of habitats. In fact, Division land within the Ware River watershed probably supports some of the highest moose densities in the state (B. Woytek, pers. comm.). Moose populations in the state suffer relatively little natural or human-caused mortality. Black bears are the only potential predator of moose and are limited to killing young calves. There are approximately 2,000 black bears in Massachusetts, and most of them are located west of the Connecticut River. As a result, current bear populations are not capable of limiting moose populations.

The main source of moose mortality is most likely from interactions with people. In 1997, twelve moose were killed on roads, four nuisance animals were destroyed, and four were immobilized and relocated (Peek and Morris, 1998). It is likely that moose/vehicle collisions will continue to rise as moose populations expand. Because moose/vehicle collisions are extremely dangerous for both humans and moose it has been suggested that moose are incompatible with an urbanized state such as Massachusetts, and the public's tolerance of moose is limited (Peek and Morris, 1998, Veccillio et al., 1993).

6.5.3.1 *Moose and Vegetation*

Moose are primarily browsers and feed on the leaves, buds, and twigs of a variety of tree and shrub species. An adult moose can consume 40-60 pounds of browse daily (Snyder 2001). During the summer, moose spend time in lakes and ponds feeding on aquatic plants.

A good deal of work has been done assessing the impact of moose on boreal forest ecosystems (Danell et al., 1991, Edenius, 1994, Angelstam et al., 2000, Connor et al., 2000, McLaren et al., 2000, Brandner et al., 1990, McInnes et al., 1992). There exists little if any information on the impact of moose in the southern portion of their range. While boreal ecosystems are relatively simple in terms of species diversity and structure, forests in Massachusetts are much more complex in both composition and processes. While information regarding moose in boreal ecosystems is important and insightful, it does not necessarily represent moose in mixed hardwood/softwood forests.

In Europe, moose were shown to have negative impacts on the quantity and quality of Scots pine (Angelstam et al., 2000). Moose density was found to be the main factor affecting the amount of moose related damage (Angelstam et al., 2000). A study in a Newfoundland park suggested that moose have changed species composition and influenced forest succession (Conner et al., 2000). Hunting has been prohibited in the park since 1974, and natural predation by black bears has not had an impact on the moose population (Conner et al., 2000). Several studies have examined the interaction of moose and Balsam fir, a preferred winter food of moose. In order to successfully regenerate Balsam fir in Newfoundland, McLaren et al., (2000) had to maintain high hunter harvest until trees were >3 meters in height. McLaren et al., (2000) concluded that since wolves were extirpated from Newfoundland, hunting has been the only option to reduce moose populations. McInnes et al., (1992) concluded that moose in the boreal forests of Michigan prevented saplings of preferred species from growing into the canopy. Further, it appeared that browsing by moose influenced the long-term structure and dynamics of the boreal forest ecosystem (McInnes et al., 1992).

Compared to the relatively simple ecosystem of the boreal forest, Massachusetts's forests are comprised of a diversity of hardwood and softwood species. The impact of moose on any particular species is unknown. However, there is substantial evidence linking overabundant deer populations in hardwood forests with negative environmental impacts (McShea et al., 1998). If moose populations continue to expand, the potential exists for moose to impact forest ecosystem structure and function. Localized browsing damage has already been anecdotally noted, particularly during winter weather when moose mobility is more limited and browse pressure becomes locally intense.

6.5.3.2 *Monitoring*

Because moose populations are expanding in Massachusetts and little is known about the potential impacts of moose on forest ecosystems, it is important to monitor moose populations. To date, monitoring done by biologists at MassWildlife consists of recording road kills, nuisance reports, and a preliminary radio-telemetry study. While this method gives a crude index of relative abundance, it does not monitor population density or reproductive characteristics.

In April 2002, the Division began a moose monitoring program on the Ware River watershed (MDC 2002) to provide information on the relative abundance of moose populations within each study area. Monitoring will continue yearly on the Ware River and will gradually spread to other Division watersheds.